# Risk Management

Volume 4, Issue 2 | QUARTERLY | December 1996


***Letter From the Editor:***

***This is the second issue of the Risk Management Quarterly edited and compiled by Lane Environmental, Inc. We apologize for the lateness of this issue, but you can expect to receive the next issue in January. Thank you to the authors who provided excellent material to challenge our thinking.***

***In November Ken Murphy (EH-30), Dr. Suzanne Clarke (Richland Field Office) and I set the following goals for this publication. We intend to minimize printing by posting the RMQ on the internet during FY97. We also wish to continue to maintain a broad risk focus, including process safety and environmental risk. Lastly, we wish to encourage more field office involvement throughout the complex.***

***Your comments and thoughts on the articles are welcome. If you will contact me at the address below, we'll include some of the responses in our next issue.***


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## Inside This Edition



# A Qualitative Method for Assessing Risk


***by Jeffrey A. Mahn, Sandia National Laboratory Albuquerque, New Mexico***


Many DOE facilities only require a qualitative, rather than a quantitative, methodology for assessing risks. Sandia National Laboratories and Science Applications International Corporation have developed a qualitative risk assessment methodology that is relatively inexpensive to perform yet achieves the higher quality results characteristic of more costly quantitative methods. In addition, the methodology meets the requirements of DOE orders 5481.1B and 5480.23 which call for the dominant contributors to a facility's risk be identified and managed.

This qualitative methodology is based on the risk assessment "binning" criteria provided in DOE/AL Supplemental Order 5481.1B and draws upon experience gained from performing quantitative risk assessments. The methodology helps perform more defensible qualitative risk assessments and provides a guide for reviewing qualitative assessments in a consistent manner.

## Developing Accident Sequences

Applying this methodology begins by developing hazard or accident scenarios, which are based on initiating events, physical structures, systems and equipment failures, and human performance errors. The methodology uses the event tree of Figure 1 to segment the elements of an accident sequence into 1) initiating events, 2) system responses, 3) operator mitigating actions, and

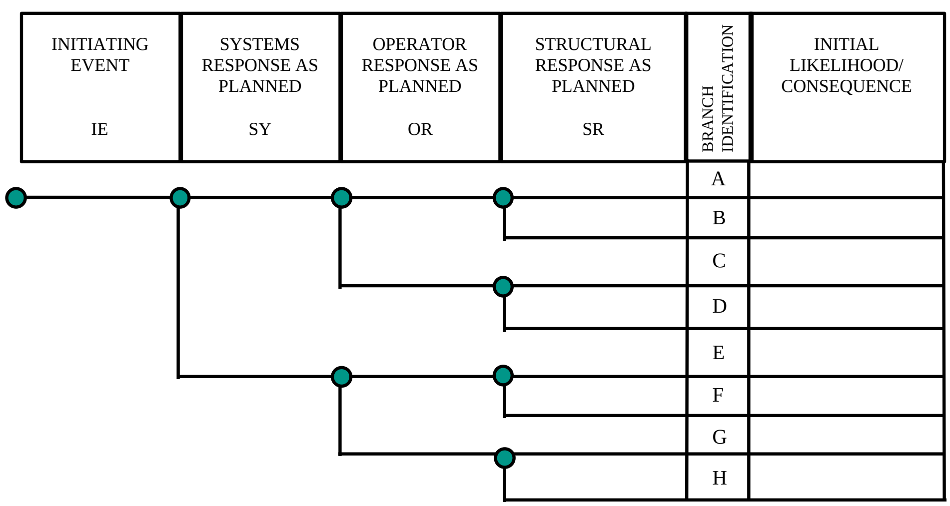


**FIGURE 1. Event Tree for Accident Sequence Development**


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4) structural responses. These elements have been represented in the event tree as top events. The down branches represent failure conditions that contribute to the likelihood of an accident, and the horizontal branches represent success paths. This event tree is therefore used to qualitatively define potential accident sequences as successes and failures of structures, systems, and human action elements.

## Determining Likelihood of Occurrence and Consequence Bins

The overall likelihood of an accident scenario occurring is determined by the use of qualitative-to-quantitative linkages to evaluate the frequency or failure probability of each sequence element. The qualitative side of these linkages consists of "generic" descriptions of initiating events, system-level failures, structural failures, and human performance errors. The quantitative side of the linkages consists of "generic" frequency/failure probability data derived from representative equipment and system failure rates, human reliability studies, and engineering judgment. A table of linkages for each of the accident sequence elements is provided in the methodology documentation.

The overall likelihood that an accident sequence may occur can be estimated, for the purpose of binning, by combining the frequency/probability of each element in the sequence. For example, the probability for branch E in Figure 1 is the product of the initiating event frequency and the probabilities for a failed systems response, successful operator response, and successful structural response. This can be represented as:

$$P = IE \times \underline{SY} \times OR \times SR$$

where IE is the initiating event frequency; <u>SY</u> is the probability that applicable facility systems <u>fail</u> to respond to the initiating event as planned; OR is the probability that facility personnel respond to the initiating event correctly; and SR is the probability that applicable facility structures function as intended in response to the initiating event.

The "generic" frequency/failure probability data provided in the methodology documentation consists of both applicable ranges and nominal (point-estimate) values. Adjustment factors are provided to support increasing or decreasing the nominal values based on facility-specific conditions and existing risk management practices. The system-level failure probability data include the contribution of common failure modes for typical system designs. If necessary, common failure modes between accident sequence elements can be accounted for by event tree modeling of such dependencies together with the application of appropriate adjustment factors to generic failure probabilities.

The methodology documentation also includes "generic" consequence models for assessing (binning) human health and safety impacts, environmental impacts, and programmatic impacts.

## Determining Risk Acceptability

Matrixing of the consequence and likelihood of occurrence bins results in a 16 bin structure, as shown in Figure 2, that can be partitioned to indicate the particular combinations of consequence severity and likelihood of occurrence that are considered to result in acceptably low risk, unacceptably high risk, and intermediate risk levels. The partitioning shown in the figure provides appropriate risk decision making criteria for risks evaluated using this methodology. Decision makers must keep in mind, however, that the partitioning boundaries shown in Figure 2 do not represent allowable targets, but rather should be viewed as metrics for gauging the degree to which additional risk control measures are warranted. RMQ

Increasing Likelihood of Accident Scenario

| Likelihood Categories | | | | |
|---|---|---|---|---|
| A | Acceptable - risk management actions prudent | Risk management actions prudent | Unacceptable - risk management actions required | Unacceptable - risk management actions required |
| B | Acceptable | Acceptable - risk management actions prudent | Risk management actions prudent | Unacceptable - risk management actions required |
| C | Acceptable | Acceptable | Acceptable - risk management actions prudent | Risk management actions may be needed to limit potential consequences |
| D | Beyond design basis events - Acceptable | Beyond design basis events - Acceptable | Beyond design basis events - Acceptable | Beyond design basis events - Acceptable |
| Consequence Categories | IV | III | II | I |

Increasing Severity of Consequences

Actions required to manage risk

Actions to manage risk are prudent

Actions may be needed to limit consequences

**FIGURE 2. Risk Decision Making Matrix**

# CRESP Completes Reviews

***by Michael Kern, CRESP Consultant***
***Madrona Resource Associates***

The independent CRESP panels that reviewed the U.S. Department of Energy Environmental Budget process were unanimous in supporting the continued implementation, revision and refinement of risk-influenced management systems in the EM planning and decision-making process.

Responding to a request from then-Assistant Secretary for Environmental Management Thomas P. Grumbly and recommendations from its Advisory Board, the Environmental Management Program (EM) at DOE established a three-tier review process to assess its efforts to align budgets with risks. The first level involved a review by managers and administrators at DOE sites. The second and third tiers involved two different groups convened by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) (see article on CRESP in the July 1996 issue).

## Tier 2: National Review Panel

For the Tier 2 Review, CRESP assembled a National Review Panel (NRP) of experts in human health and ecological risk assessment, nuclear engineering, hydrology and health physics. The NPL reviewed the data contained in Risk Data Sheets (RDS) submitted by DOE/EM field offices as part of their FY 1998 budget request.

The Tier 2 review demonstrated CRESP's ability to provide review and guidance quickly and effectively. The 14-member Panel (chaired by Dr. John A. Moore, Director of Science Coordination for CRESP and president/CEO of the Institute for Evaluating Health Risks) reviewed in 15 days more than 400 of the 1408 RDSs submitted for the FY 1998 budget. The Panel focused on three broad areas: 1) independent verification of ratings, statements or conclusions contained within the RDSs; 2) cross-site consistency in use of key terms, elements and ratings in the RDS matrix; and 3)the degree to which the information in the RDS conformed with the EM budget guidance.

Overall, the Panel found that the RDS can be a valuable management evaluation tool because it "permits the consideration of quantitative information along with the views and judgments of managers, stakeholders and technical personnel" (NRP Report, 5/1/96, p.1). The Panel found shortcomings, however, and recommended that the current RDSs be used cautiously, augmented by other information when major issues arise. A common shortcoming was a lack of sufficient detail in the narratives to understand the tasks involved or the basis for assigning high, medium or low designations to various risks in the matrix. Another was a lack of cross-site consistency and social, cultural and economic impact elements. A third was a failure to include references to and quotations from documents, reports, meetings, audits, agreements, etc., to convey that the conclusions reached in the RDS were not arbitrary pronouncements. The panel also felt that some site activities, for example road maintenance and fire protection, are not appropriate for description and ranking using the risk elements of the RDS matrix. Finally, the Panel had concerns about the lack of incorporation of stakeholder values into the Social/Cultural/ Economic category. The Panel felt that the quality of the RDSs correlated with the level of interaction with stakeholders, tribal nations, regulators and other parties during the RDS development process.

**"Although EM is still at a relatively early stage in learning how to use risk analysis as a tool in budget formulation, it has taken a major step forward and should continue the process."**
**Peer Review Committee**

## Tier 3: Peer Review Committee

In Tier 3, EM's entire priority-setting process was reviewed by CRESP's Peer Review Committee (PRC), an interdisciplinary group of experts not directly involved in EM budget activities or the Tier 2 review. The PRC is headed by Dr. Arthur Upton, Clinical Professor of Environmental and Community Medicine at the University of Medicine and Dentistry of New Jersey/Robert Wood Johnson Medical School. This independently-operating Committee was formed by CRESP to ensure the scientific quality of CRESP's studies and to maximize their credibility and acceptability to stakeholders. Members of the Committee reviewed documents and reports, observed Tier 2 and EM budget meetings, and interviewed DOE headquarters, field office and contract personnel, stakeholders and others.

The Peer Review Committee found that EM's Management Evaluation process (MEP) for the FY 1998 budget, "represents a significant and creditable step forward in the evolution of an integrated approach for 1) characterizing the risks to public health, worker safety and the environment in the DOE Nuclear Weapons Complex; 2) linking such risks to compliance, fiscal and other considerations; 3) involving stakeholders in the planning of mitigation efforts and future land use options; and 4) providing a multi-

> **"The CRESP Peer Review Committee strongly endorsed DOE's efforts to address risks and other stakeholder concerns systematically and explicitly in formulating its program plans and budget for FY 1998."**
> **Dr. Arthur Upton**

tiered peer review of the budget formulation process" (PRC Report, 1996, p.2). Among the MEP's strengths, said the Committee, was its provision for explicitly documenting and evaluating the seven matrix elements in prioritizing environmental management activities. They also praised it for increasing the "transparency" of the priority-setting process (making explicit to the public the reasoning behind the ranking of activities), for fostering cross-site consistency and for building stakeholder involvement and DOE/stakeholder relations.

The Tier 3 review found many of the same shortcomings in the process reported by the Tier 2 panel, and recommended ways to improve the process. They called for more careful and consistent planning, communication and commitment to stakeholder involvement at all levels of the organization. They recommended that systematic and explicit assessment of potential risks to site workers, off-site populations and the environment continue to be an essential part of EM's priority-setting process and that such assessments more adequately consider chemical hazards in addition to radiation hazards and long-term as well as short-term effects. They recommended that the process focus risk evaluation on programmatic objectives and alternative ways of accomplishing those objectives, rather than on the individual activities themselves. They suggested that EM provide more central guidance and control of the process, implement it in incremental stages over a period of years, and subject it periodically to outside peer review.

To most effectively use limited resources, the Committee suggested a "rolling steward- ship strategy where intermediate risk hazards are stabilized and observed for up to eight years, until new technologies, social perceptions or maintenance costs shift a hazard to the high- or low-risk category and it is treated accordingly. Other improvements suggested by the Committee included 1) more adequate consideration of future land use options in project planning; 2) more realistic assumptions in risk scenarios about possible restrictions on groundwater use; 3) more adequate consideration of potential cost reductions from emerging technologies; and 4) more systematic consideration of potential impacts from accidents in transporting wastes.

For more information about CRESP or the Tier 2 and Tier 3 reviews, contact Tiffany Potter-Chile at CRESP-University of Washington's administrative offices, (206) 543-9394. RMQ

The ***Risk Management Quarterly*** is published every January, April, July and October. We apologize for the lateness of this issue, but you can expect to receive the January issue on time. Articles are reviewed before publication by the following members of the **Editorial Review Board:**



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# Developing Protocols for Balancing and Communicating Environmental Risk Management Decisions

***by Peter Brussock, Environmental Liability Management, Inc. Doylestown, Pennsylvania***

The American Society for Testing and Materials (ASTM) has approved a new subcommittee to look at Balancing and Communicating Environmental Risk Management Decisions.

Historically, risk management has been a linear process, beginning with a scientific risk evaluation and ending with an evaluation of engineered risk reduction options. Scientific research findings and field investigations provided the baseline information for the risk assessment which fed a risk management process. The focus was on a cleanup number (acceptable theoretical risk) or a regulatory standard which the remedial or engineering action attempted to achieve. Most solutions were to move the problem to another location (landfill) or apply some technology control. There were clear distinctions between risk assessment and risk management. Conservative assumptions were used to address uncertainties in all steps of the process to ensure the evaluation would protect human health and ecosystems. Frequently this resulted in very expensive risk management strategies which most environmental professionals thought excessive and not always technically attainable.

In recent years, there has been a growing recognition that the risk management process should be based on realistic risk estimates and include feedback loops to develop information which reduces uncertainty, subsequent costs, and risks to acceptable levels. For example, field work should be multi-phased and focused on gathering both realistic risk characterization and engineering evaluation information. However, this risk analysis process still has limitations. The risk management decision is still selected at the end of a largely linear process. Often the decision is not connected with key toxicity, field data, and risk assessment information, and the risk management decision-maker is not familiar with all the information. Also, stakeholders have limited input, and the scientific/technical information is not presented so stakeholders can understand it.

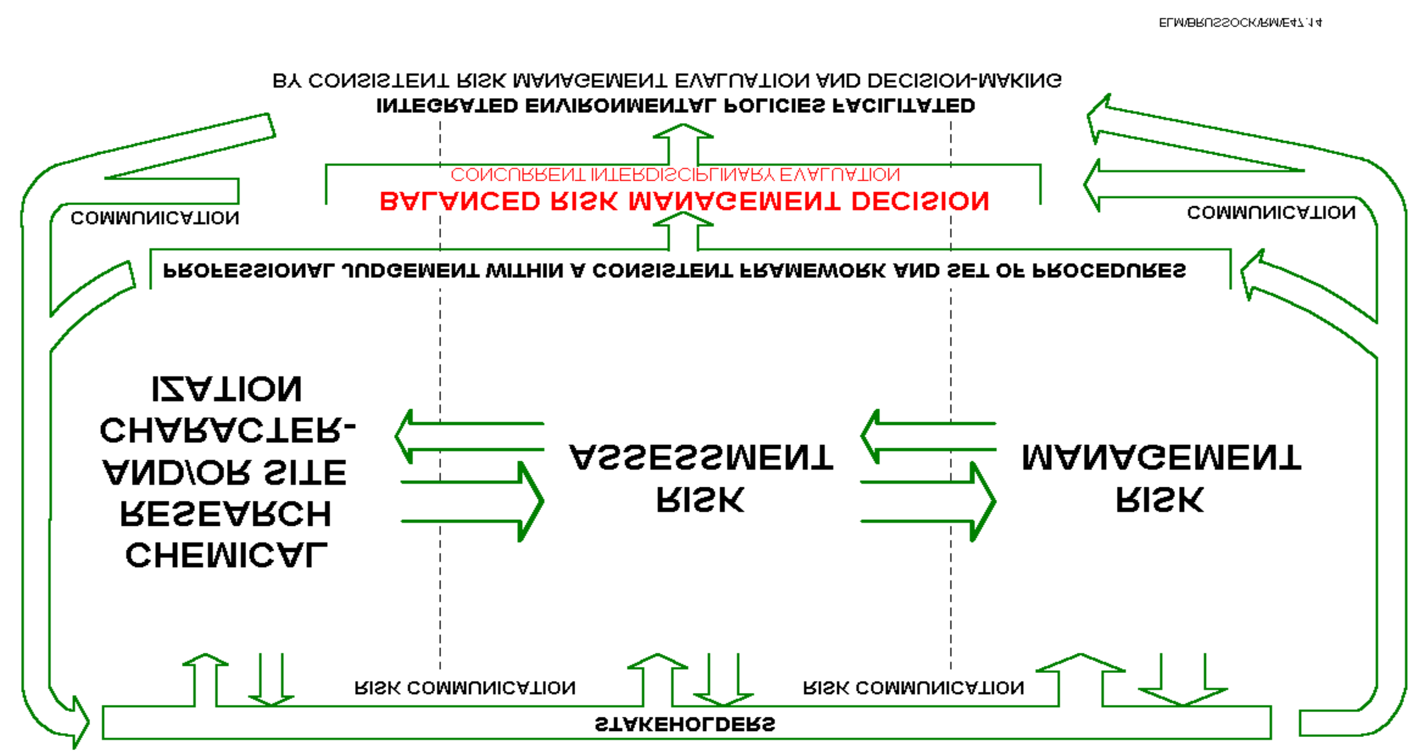
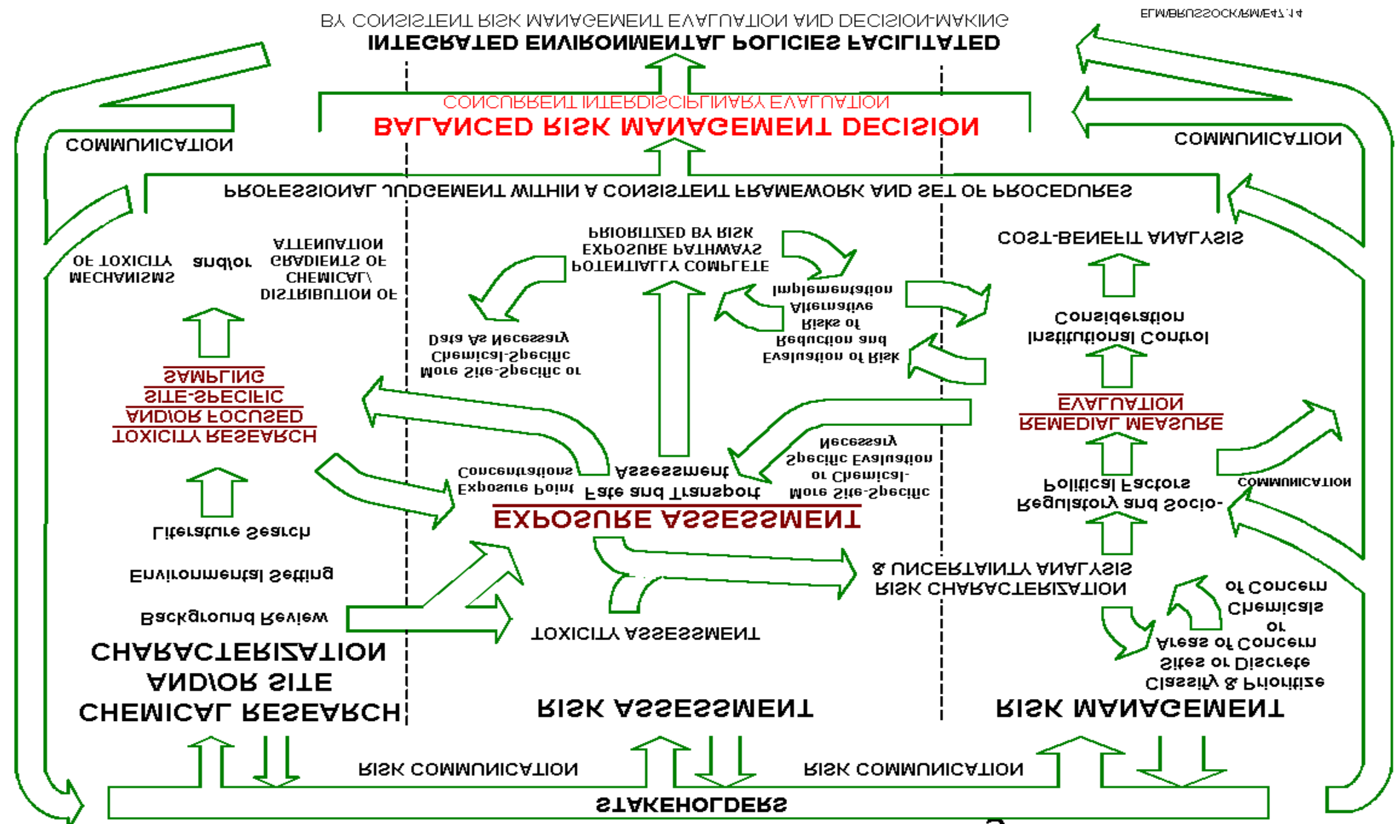



Figure 1
Generalized Environmental Risk Management Decision-Making Framework and Information Flow Diagram




Framework and Information Flow Diagram
Environmental Risk Management Decision-Making
Figure 2

There is a growing effort to make environmental risk management an interdisciplinary approach where the key information from each relevant discipline is concurrently evaluated. This results in a more balanced risk management decision and considers stakeholder input throughout the process (Figure 1). The entire process is focused on gathering and evaluating information which will let decision-makers select a balanced risk management decision based on available data, risk assessment and risk management evaluations, and stakeholder interests. Feedback loops are included. The ASTM Risk-Based Corrective Action (RBCA) (E1749) standard for petroleum is one example of this type of approach.

The objective of a new ASTM subcommittee (E47.14) is to develop a risk management decision-making framework and procedures that managers can use to reach balanced risk management decisions. The process would be an interdisciplinary approach and would include stakeholder concerns. Such a set of standards would help agencies (EPA, states, etc.) compare the relative risks and cost-benefits of risk management options for various environmental concerns (drinking water, contaminated sites, pesticide applications, radon, etc.). Subsequently, they could allocate financial resources more objectively based on total risk reduction rather than generalized perceptions of risk reduction benefits.

Initially, the subcommittee will focus on establishing the risk management decision-making framework.

Task groups will work on the two following areas:

1. Develop standards to focus relevant scientific research, field work, and risk assessment process on developing and presenting information of primary importance in making risk management decisions that include stakeholder concerns to the extent practicable. In addition, develop standardized guidelines for summarizing and presenting the most relevant risk management information to facilitate an interdisciplinary perspective in risk management decision-making. The task groups will coordinate their work closely with the existing committees on toxicity assessment, sampling, and risk assessment
2. Develop standards for conducting the components of risk management, incorporating stakeholder concerns, selecting a

balanced risk management alternative, and documenting the chosen risk management decision.

### Environmental Risk Management Decision-Making Framework

The proposed framework for environmental risk management decision-making consists of five fundamental components (Figure 1).

- Stakeholder Needs, Concerns and Interests
- Chemical Research and/or Site Assessment
- Risk Assessment
- Risk Management
- Balanced Risk Management Decisions

These components are all interrelated and linked (Figure 2). The relative importance of each component and its subcomponents varies with each environmental problem, as well as, the professional judgment of the risk manager and other participants in the process. The Exposure Assessment (based on the chemical risk management principle of: no exposure, then no risk; reduced exposure, reduced risk) is central to this evaluation. Consequently, exposure reduction or elimination is commonly a major component of most risk management strategies, especially where removing or destroying a pollutant is limited by existing technology.

### Invitation to Participate

The scope of the new subcommittee is broad, but the benefits are substantial. Environmental professionals who can contribute to some portion of the ambitious undertaking are encouraged to participate. More information concerning scheduled subcommittee and task group meetings can be obtained from the author or Susan Canning at ASTM (610)832-9500. RMQ

# EPA's Risk Management Program for Accidental Releases

Development of a Risk Management Program (RMP) is one requirement of several imposed by EPA's "Accidental Release Prevention" rule. Regulated entities must also conduct a hazard assessment, implement an emergency response program, and comply with several other new requirements depending upon the level of risk posed by their particular process. With a three-year phase-in period for compliance, most processes have until June 1999 to comply, but EPA is encouraging owners and operators to start preparing for compliance now.

The Accidental Release Prevention rule applies to "owners or operators of a stationary source that has more than a threshold quantity of a regulated substance in a process." There are many regulated substances including 77 toxic substances and 63 flammable substances, such as ammonia, chlorine, hydrogen, propane, sulfur dioxide and sulfuric acid. Many processes, such as use, storage, manufacturing, handling or on-site movement, of a regulated substance is included.

Requirements of the rule correspond to the level of risk posed by the regulated processes. As such, processes are divided into three tiers, called programs, according to criteria such as whether that process has had an accidental release with off-site consequences in the previous five years. Any one facility could easily include more than one program.

The RMPs are designed to serve two purposes: (1) provide enough information to allow governmental authorities to determine whether the source is in compliance with the rule, and (2) provide understandable information about prevention and preparedness to the public. All owners or operators of a covered process must submit an RMP.

An RMP consists of a registration form that specifies, among other things, all regulated substances handled in covered processes, the maximum quantities of each regulated substance on-site, and the date of the last safety inspection. Each RMP must also include a brief description of the source's activities as they relate to covered processes, and program and data information that addresses compliance with each element of the rule. Once submitted to EPA, the RMPs will be electronically accessible to States, local entities (including local emergency planning committees) and the public. The plans must be updated every five years or within six months after a process change which alters the hazard assessment or Program (1, 2, 3) designation.

The hazard assessment consists of two basic parts—off-site consequences analysis and five-year accident history. The owner or operator must prepare an off-site consequences analysis, in-

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cluding an evaluation of "worst-case release scenarios." Processes under Programs 2 and 3 must also analyze more likely alternative release scenarios. EPA has provided various default parameters for the analyses and has developed methodologies and information on things like air dispersion models. The five-year accident history report must detail all accidental releases that resulted in death, injuries, or significant property damage on-site, or known off-site deaths, injuries, evacuations, sheltering in place, property damage or environmental damage. For more information about this program, contact the Emergency Planning and Community Right-to-Know Hotline at 1-800-424-9346. RMQ

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